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To Mr. A.D. Mosher
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H8G1

POSSIBLE INTERFERENCE TO A RADIO RECEIVING
INSTALLATION NEAR CFB BORDEN

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Two sets of field measurements strongly suggest that the proposed 500 kV Bruce-Essa transmission line passing close to the DND radio receiving site near CFB Borden will not produce measurable interference to their radio reception.

At the request of the Route and Site Planning Department, an investigation is being carried out to determine whether either of two proposed routes for the 500 kV Bruce-Essa transmission line might result in radio interference at the Department of National Defense (DND) radio receiving site near Canadian Forces Base (CFB) Borden. The two routes would pass between 800 metres and 1.3 kilometres from the site.

An earlier analysis based on field measurements and information in the technical literature had been carried out. It is summarized in the Appendix of this report. It predicted that negligible interference would result. This analysis made use of radio noise levels measured 38 metres from a 500 kV transmission line near Milton of similar construction to the proposed line. Theoretical attenuation factors were then used to predict the noise level that would exist at much greater distances from the line.

Attenuation Tests on a 500 kV Line

There was some question as to the accuracy of these attenuation factors. For this reason, further tests have now been carried out on an operating 500 kV line. Artificial "spark-gap" noise sources were placed on the line to produce high noise levels that would simulate corona noise during heavy rain or wet snow. It was planned

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to measure the lateral attenuation of the noise out to 1.3 km from the line at frequencies between 100 kHz and 30 MHz. Due to high levels of natural background noise caused by atmospheric disturbances, etc and due to instrumentation problems, only a part of this was achieved in the time available. Table I and Figures 1 and 2 summarize the results.

TABLE I

Frequency (MHz)	Maximum Lateral Distance Achieved (metres)	Rate of Lateral Attenuation $1/D^N$
0.14	125	N = 3
0.16	70	3
0.2	200	See Figure 1
0.5	400	See Figure 1
8	600	See Figure 2
16	1300	See Figure 2
30	1300	See Figure 2

In the LF band below 200 kHz the noise falls off $1/D^3$, as predicted by theory. However, since the spark-gap noise was masked by natural background noise beyond a few hundred metres from the line, it is not possible to state whether this rate of attenuation continues out to 1.3 km. At this time it is only possible to use the theoretical attenuation curves for these frequencies.

The HF attenuation curves shown on Figure 2 do not follow any expected pattern. The attenuation at 1.3 km from the line varies from 32 to 38 dB between 16 and 30 MHz. Theory predicts over 40 dB. These values are, however, not too important because corona noise will be of low level at these high frequencies.

The overall result of these tests is that we are left where we were before. It was not possible to measure the lateral LF attenuation because the line noise disappeared into normal background noise after a few hundred metres. Since the LF noise level from the spark-gap sources measured at 38 metres laterally from the line was higher than the maximum anticipated corona noise during rain, one would anticipate that the corona noise would also disappear into background noise in a few hundred metres. If this is true, the prediction that the power line at 800 metres or 1.3 km from the DND receiving site will not interfere seems to be justified.

Noise Tests at DND Receiving Site

At the present time a single circuit 115 kV power line passes within 800 metres of the DND receiving site. The spark-gap noise sources were placed on this line. It was hoped that the radio noise from these sources could be measured at the LF and HF receiving antenna terminals. In two separate tests on two successive days (one hot and hazy, the other humid with intermittent very light rain) no radio noise from the spark gap sources could be measured

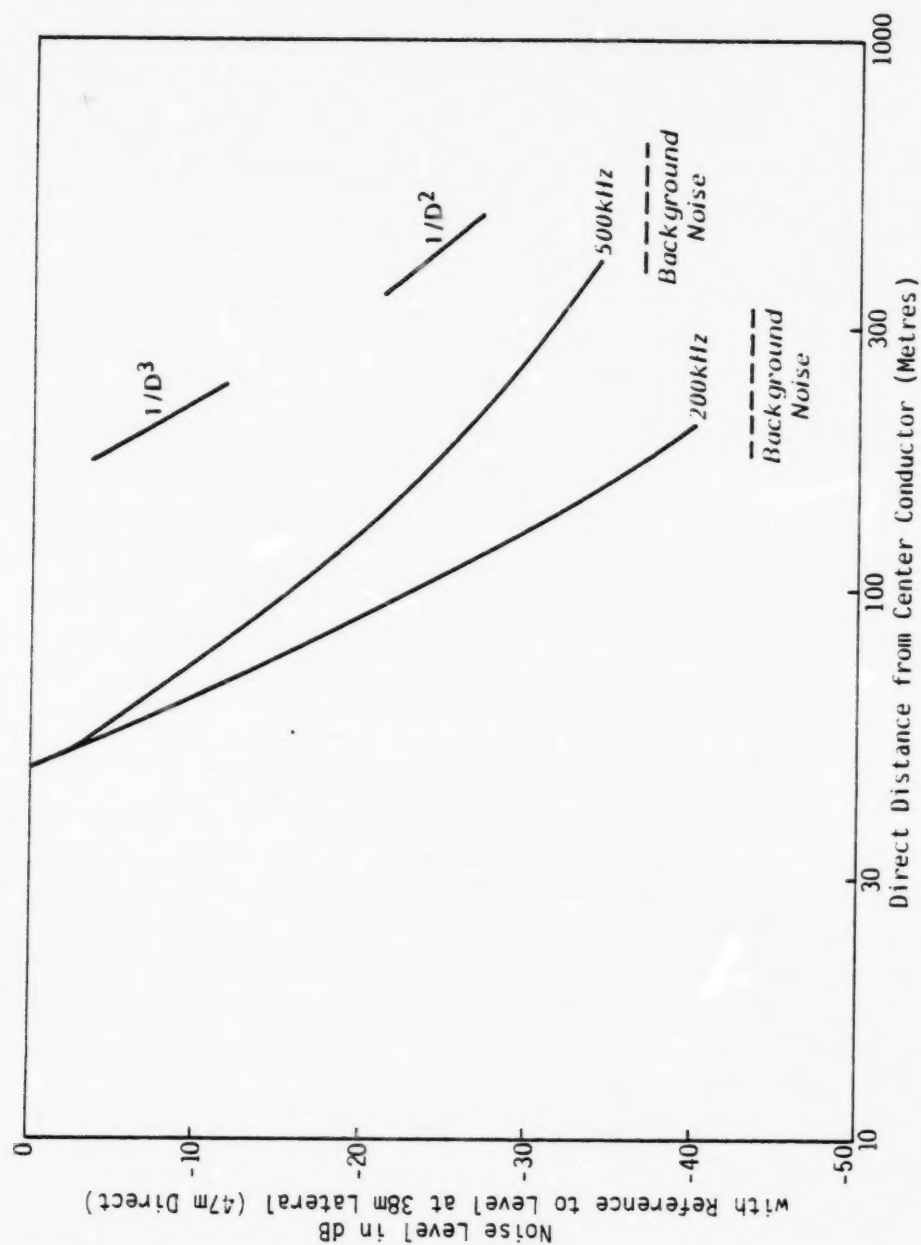


FIGURE 1
LATERAL ATTENUATION
200-500kHz

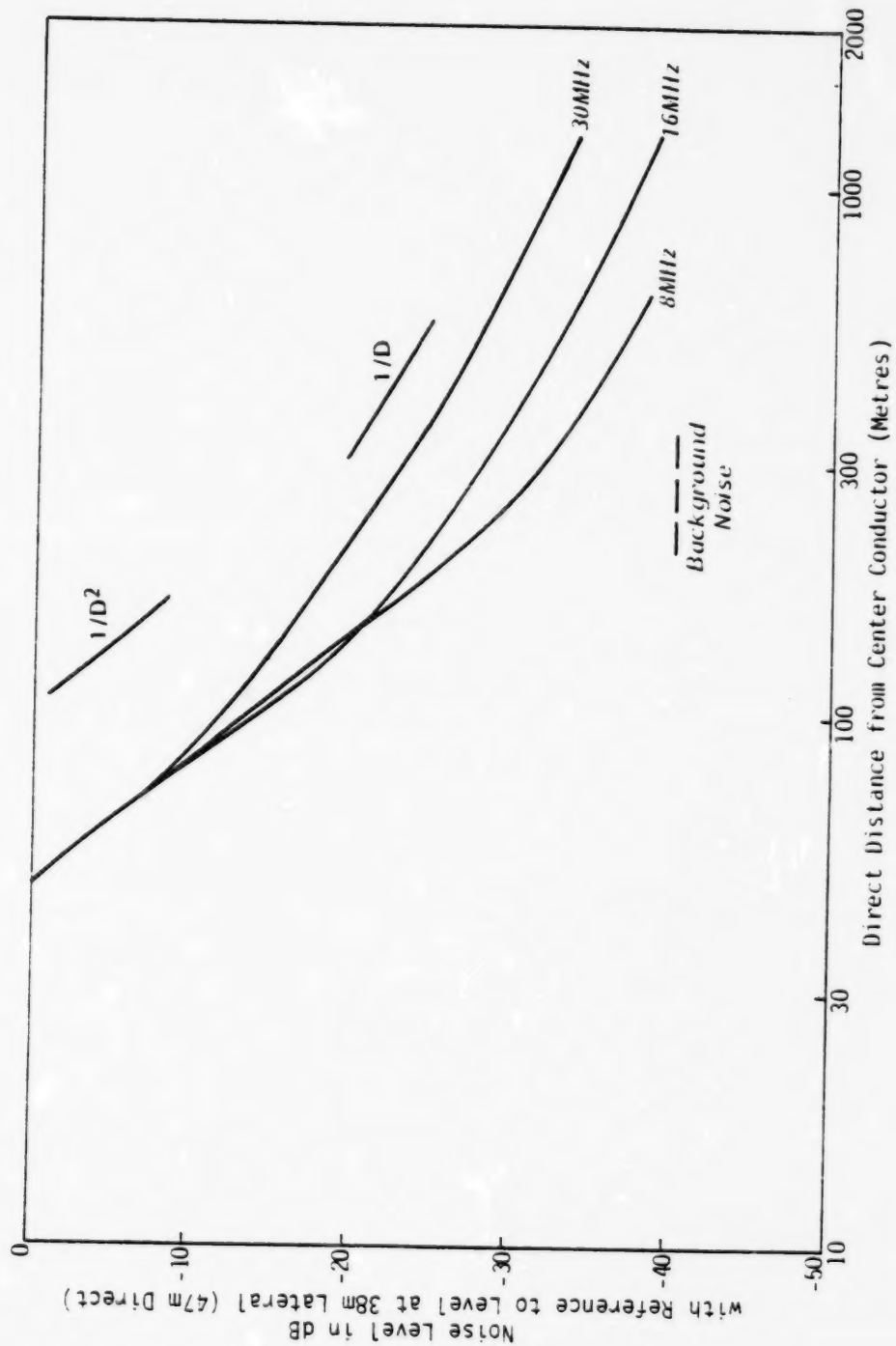


FIGURE 2
LATERAL ATTENUATION
8 30MHz

above normal background noise. Furthermore, no spark gap noise could be measured on a standard noise meter located in the middle of the receiving antenna farm. Columns A and B of Table II on page 6 summarize the measured levels. These consist entirely of normal background noise present at the receiving site. In the HF band the spark gap noise could sometimes be heard faintly in the noise meter ear phones, but the level was far below that due to normal background noise. Column C of Table II gives the noise from the spark gaps measured close to the power line.

This experiment was, therefore, not successful in its primary aim of measuring noise attenuation from the route of the existing 115 kV line to the LF and HF receiving antenna terminals. It did however allow measurement of background noise at the antenna terminals and within the antenna farm. The latter is compared in Table III to the background noise levels measured by QETE* and quoted in Table 1 of the appendix, all converted to dB above kT_0 .

TABLE III

<u>Frequency</u>	<u>Measured by QETE (Maximum 0800-1200 Hours)</u>	<u>Measured by Ontario Hydro (on morning of second day)</u>
150-165 kHz	101	100
3 MHz	64	66
10 MHz	35	43
20 MHz	20	33
30 MHz	-	31

The present levels are quite close to the QETE values at the lower frequencies. It, thus, appears that these are the natural noise levels which occur frequently and must be "lived with".

* Quality Engineering Test Establishment.

TABLE II

Measurement location*	first day no spark gaps		first day with spark gaps			second day with spark gaps		
	A	B	A	B	C	A	B	C
150-165 kHz	30,55	37,62	45,60	37,59	71	15,40	34	64
3 MHz	9	17	23	23	62	20,40	25	57
10 MHz	1	10	5	14	62	3,20	12	53
20 MHz	-5	6	0	6	58	-5	9	51
30 MHz	13	-	-	8	55	-10	10	47

* Measurement locations:

- A - Measured at the LF receiving antenna output terminal and at one of the HF receiving antenna terminals using a Singer model NM 25-T noise meter with quasi-peak detector, satisfying CSA standard C108.1.2-M 1981, in dB above 1 μ V.
- B - Measured in the middle of the antenna farm using the same noise meter with a 105 cm rod antenna and ground plane, in dB above 1 μ V/m.
- C - Measured 20 metres from the nearest conductor of the 115 kV power line in the middle of the beam of the HF and LF receiving antennas, in dB above 1 μ V/m. (The nearest point on this line is 1370 metres from the center of the antenna farm.)

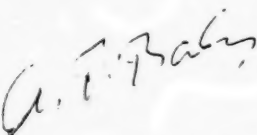
Note: In some cases two noise levels are given - the minimum and maximum over a 10 second period.

Conclusions

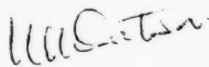
Radio noise tests with artificial sources on a 500 kV line at Milton and on a 115 kV line near Camp Borden have led us to expect that a proposed 500 kV line will not interfere with operation of the LF or HF communication facilities at CFB Borden. Both of these tests suggest that power line noise will have fallen below background noise before it reaches the receiving antennas.

Approved:

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DEJ:ta

APPENDIX

Possible Increase in Noise at the DND Radio Receiving Site near CFB Borden due to Proposed Ontario Hydro 500-kV Line

The method of predicting the Increase in Noise at the DND receiving site is as follows:

1. Measured noise level - Radio noise was measured continuously for 34 days on an NM 21-FFT radio noise meter at 500-kHz, with quasi-peak detector, at 38 metres laterally from a 500-kV line of the same construction as the proposed line. The maximum level measured was 60 dB above 1 $\mu\text{V/m}$. This occurred when it was raining at a rate of 1.5 cm per hour. At other times during the test period, rain rates as high as 6 cm per hour were recorded. The radio noise, however, did not exceed 60 dB above 1 $\mu\text{V/m}$.*
 2. Frequency Corrections - Frequency correction curves for radio noise on high voltage transmission lines are given in the CSA standard on EMI of electric power systems/1/. (These same curves are presented in the proposed federal radio regulations concerning permissible radio noise levels from power lines.) The frequency corrections are shown in column 3 of Table 1.
 3. Corrections to agree with DND Measurements - The DND background noise measurements were carried out using an NM 26-T noise meter with RMS detector. This meter has the same bandwidth as the NM 21-FFT, and should respond identically to power line noise. There is no simple theoretical correlation between quasi-peak and RMS detectors. Field tests have been carried out, however, using meters with both detectors/2/. They showed:
Ratio of QP/RMS = 10.0 dB at 500 kHz
 = 8.9 dB at 1 MHz
 = 8.4 dB at 1.65 MHz
There is no reason to expect large changes in this ratio with frequency, as long as the receiver bandwidth does not change. An average value of 9 dB is, therefore, used for all frequencies in column 4 of Table 1.
 4. Conversion of Measuring Units - The power line noise measurements are given in dB above 1 $\mu\text{V/m}$. The DND measurements are given in terms of F_A , or dB above kTo. Corrections, based on Equation (1) in Reference 3, are shown in column 5.
- * Note - The noise level of 60 dB above 1 $\mu\text{V/m}$ occurred only for a very short time during heavy rain. For about 97% of the time noise did not exceed 54 dB above 1 $\mu\text{V/m}$. Thus, any possible interference would occur only for very short periods of time.

5. Lateral Attenuation - Very little work has been carried out on lateral attenuation of power line noise outside of the AM broadcast band, 0.54-1.6 MHz, or at distances beyond about 100 metres. One extensive field survey was carried out in the 1960's/4, 5/. Based on its results, the authors presented lateral attenuation curves for the whole RF band up to 10 GHz and for distances up to 15 km. Much of this was theoretical, but was verified by the field measurements for distances out to about 300 metres. These curves are used to predict the lateral attenuation from 38 metres to 800 metres, 1 km and 2 km in columns 6 to 8.
6. The last three columns in Table 1 give the maximum predicted increase in noise level at the DND receiving site due to a 500-kV line at the three distances from the receiving site. The maximum morning noise levels from Table 2 of the QETE report were used for this calculation.

REFERENCES

1. CSA Standard C108.3.1-1975, Tolerable Limits and Methods of Measurement of Electromagnetic Interference from Alternating Current High Voltage Power Systems, 0.15 MHz - 30 MHz.
2. A Field Comparison of RI and TVI Instrumentation, Task Force of the IEEE Radio Noise and Corona Subcommittee, IEEE Transactions on Power Apparatus and Systems, May/June 1977, p. 863-75.
3. Radio Noise Surveys at Canadian HF Communication Sites, W.E. Lauber, IEEE Transactions on EMC, May 1977 p 44-49.
4. High Voltage Line Siting Criteria, Volume 1, High Voltage Power Line Test Results, analysis and appendices. W.E. Pakala, E.R. Taylor, R.T. Harrold, Rome Air Force Development Center, Griffiss US Air Force Base, report RADC-TR-66-606-Volume 1, March 1967.
5. Radio Noise Measurements on Overhead Power Lines from 2.4 to 800 kV, W.E. Pakala and V.L. Chartier, IEEE Transactions on Power Apparatus and Systems, May/June 1971, p 1155-1165.

Table 1

Predicted Increase in Noise at Receiver Site due to 500-kV Line at various distances from the Site

Frequency (kHz)	Maximum Measured Noise Level (dB above 1 µV/m)	Frequency Correction (dB)	QF/QMS Correction (dB)	10/m to F Correction (dB)	Attenuation (dB)			Maximum Predicted Noise Level (dB above KHz)			Noise at Rx Site (dB above KHz)		Maximum predicted Increase in Noise at Rx Site (dB) for Power Line At		
					To 800 m	To 1 km	To 2 km	At 800 m	At 1 km	At 2 km			800 m	1 km	2 km
0.17		+ 11.5	- 9	74.9	58	60	66	79	77	71	101		0	0	0
0.40		+ 5.5	- 9	70.0	47	50	55	80	77	72	81		2	1	0
0.50	60	0	- 9	65.5	39	40	46	78	77	71	73		6	5	2
1.0		+ 13.2	- 9	54.5	25	27	34	67	65	58	69		2	2	0
2.5		- 17	- 9	51.5	26	28	35	60	58	51	66		1	1	0
5.0		+ 25	- 9	45.5	29	31	40	43	41	32	58		0	0	0
6.6		+ 28	- 9	43.1	31	33	43	35	33	24	50		0	0	0
9.0		- 31	- 9	39.7	34	37	48	24	21	10	35		0	0	0
15		38.5	- 9	36.0	37	40	52	12	9		30		0	0	0
40		- 42	- 9	33.5	38	42	54	5	1		20		0	0	0
75		43.5	- 9	31.5	39	43	55				22		0	0	0

Notes: Noise was measured at 500 kHz, using an NM 21-FET Noise meter with quasi-peak detector, located 16 metres laterally from the 500-kV Milton Clarendon Transmission Line.

"Noise at Rx Site" is the "Max" Noise from Table 2 of QTE report.

QF/QMS correction = 9.5 dB for 100 Hz

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